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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/815,994	03/31/2004	Chung J. Lee	DSI 303	7286

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EXAMINER	
COLEMAN, WILLIAM D	

ART UNIT	PAPER NUMBER
2823	

DATE MAILED: 10/14/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

AK

Office Action Summary	Application No.	Applicant(s)	
	10/815,994	LEE ET AL.	
	Examiner	Art Unit	
	W. David Coleman	2823	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *05 August 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-50* is/are pending in the application.

4a) Of the above claim(s) *39-50* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-38* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *10/04;01/05*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Election/Restrictions

1. Applicant's election without traverse of Group I, claims 1-38 in the reply filed on August 5, 2005 is acknowledged.

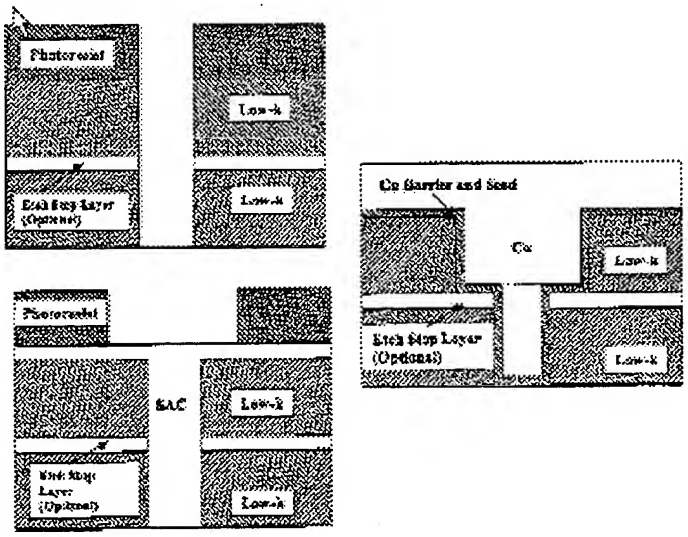
Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. Claims 1-38 are rejected under 35 U.S.C. 103(a) as being unpatentable over Daniels et al., U.S. Patent 6,583,047 B2 in view of Lee et al., U.S. Patent 6,051,321.

4. Daniels discloses a semiconductor process substantially as claimed. See **FIGS. 1a-11h** where Daniels teaches the following limitations.



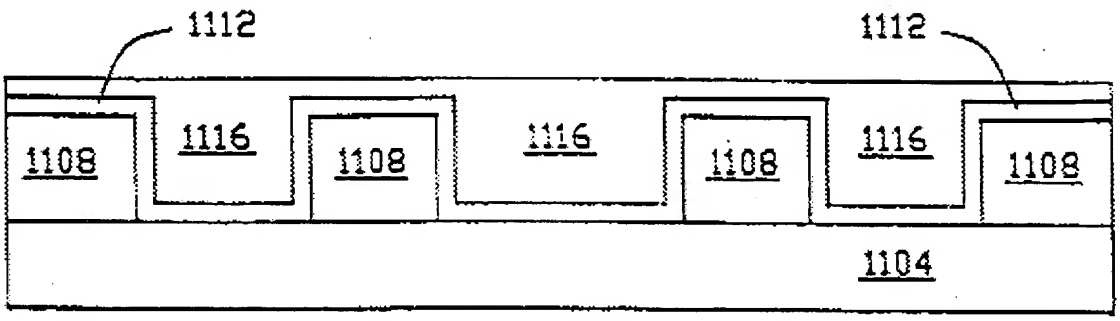
5. Pertaining to claim 1, Daniels teaches a method of forming an electrically conductive element in an integrated circuit, the method comprising:

depositing a composite polymer dielectric film (first low-k film) onto a substrate (not shown), wherein the composite polymer dielectric film includes a silane-containing adhesion promoter layer formed on the silicon-containing substrate, and a low dielectric constant polymer layer formed on the adhesion promoter layer;

depositing a silane-containing hard mask layer (see column 8, line 1 and column 21, lines 13-15) onto the composite polymer dielectric film;

exposing the hard mask layer and the adhesion promoter layer to a free radical generating energy source to chemically bond the adhesion promoter layer to the underlying silicon-containing substrate (see column 13, lines 10-12) and to the low dielectric constant polymer layer, and to chemically bond the composite polymer dielectric film to the hard mask layer (the hard mask layer is disclosed in column 21, lines 13-18);

etching am etched feature in the hard mask layer and the composite polymer dielectric film; and depositing an electrically conductive material in the etched feature. However, it is not clear that Daniels discloses an adhesion promoter layer, which is exposed to a free radical generating energy source to chemically bond the adhesion promoter layer to the underlying silicon-containing substrate. Lee (321) teaches exposing a free radical generating energy source to chemically bond the adhesion promoter layer to the underlying silicon substrate.



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6. In view of Lee (321), it would have been obvious to one of ordinary skill in the art to incorporate the exposing a free radical generating energy source to chemically bond the adhesion promoter layer to the underlying silicon substrate in the Daniels semiconductor process because a desirable energy source is incoherent excimer radiation that is derived from a dielectric barrier discharge (column 12, lines 9-16).

7. Pertaining to claim 2, Daniels in view of Lee(321) teaches the method of claim 1, wherein the adhesion promoter layer and the hard mask layer are each formed from at least one material having a general structure of $(RZ)_x$-Si-$(W\text{-}T)_Y$, wherein W is selected from the group consisting of -O-, $-CH_2-$, $(CH_2)_aC{=}OO-$, and $-(CH_2)_a-OO{=}C-$;

wherein T is selected from the group consisting of CR=CR'R", an alkyl halide, and -RC=O;

wherein Z is selected from the group consisting of O and NR;

wherein R, R' and R" are an H, alkyl or aromatic group;

wherein a is 0 or an- integer; wherein x = 1, 2 or 3; wherein y = 1, 2 or 3; and wherein x + y = 4 (see claims 13-15).

8. Pertaining to claim 3, Daniels in view of Lee(321) teaches the method of claim 2, wherein the hard mask layer is formed from an organosilane having a general formula (RZ)-Si-$(W\text{-}T)_3$.

9. Pertaining to claim 4, Daniels in view of Lee teaches the method of claim 1, wherein the adhesion promoter layer and the hard mask layer are each formed from at least one material having a general structure of $H_xSi(W\text{-}T)_y$, wherein W is selected from the group consisting of -O-, $-CH_2-$, $-(CH_2)_aC{=}00-$, and $-(CH_2)_a-OO{=}C-$;
wherein T is selected from the group consisting of -CR=CR'R", an alkyl halide, and =RC=O;
wherein R, R' and R" are an H, alkyl or aromatic group;
wherein a is 0 or an integer; wherein x = 1, 2 or 3; wherein y = 1, 2 or 3; and wherein x + y=4.

10. Pertaining to claim 5, Daniels in view of Lee(321) teaches the method of claim 1, wherein the low dielectric constant polymer layer is formed from a poly(paraxylylene)-based polymer.

11. Pertaining to claim 6, Daniels in view of Lee(321) The method of claim I, further comprising forming a silane-containing barrier layer over the hard mask layer, forming a second low dielectric constant polymer layer over the barrier layer, forming a silane-containing etch stop layer over the second low dielectric constant polymer layer, and exposing the barrier layer and the etch stop 'layer do the free radical-generating energy source to cause the etch stop layer and the barrier layer to chemically bond to the second low dielectric constant polymer layer.

12. Pertaining to claim 7, Daniels in view of Lee (321) The method of claim 6, wherein the etch stop layer is formed from at least one organosilane having a general formula $(RZ)_3$-Si-(W-T}, wherein W is selected from the group consisting of -O-, $-CH_2-$, $=(CH_2)_aC=OO-$, and $-(CH_2)_a-OO=C-$;

wherein T is selected from the group consisting of -CR=CR'R", an alkyl halide, and -RC=O;

wherein Z is selected from the group consisting of O and NR;

wherein R, R' and R" are an H, alkyl or aromatic group, and Wherein a is 0 or an integer.

13. Pertaining to claim 8, Daniels in view of Lee (321) teaches the method of claim 6, further comprising forming a third low dielectric constant polymer layer over the etch stop layer.

14. Pertaining to claim 9, Daniels in view of Lee (321) teaches the method of claim 8, further comprising forming a second hard mask layer over the third low' dielectric constant polymer layer.

15. Pertaining to claim 10, Daniels in view of Lee (321) teaches the method of claim 9, wherein exposing the hard mask layer and the adhesion promoter layer to a free radical-generating energy source includes simultaneously exposing

16. Pertaining to claim 11, Daniels in view of Lee (321) teaches the method of claim 10, further comprising: etching a via through the third low dielectric constant polymer layer, the etch

stop layer, and the second low dielectric constant polymer layer; etching a trench through the third low dielectric constant polymer layer, wherein the trench at least partially overlaps the via; and depositing an electrically conductive material in the via and the trench.

17. Pertaining to claim 12, Daniels in view Lee (321) teaches the method of claim lI, further comprising removing electrically conductive material from surfaces adjacent the trench via chemical-mechanical polishing.

18. Pertaining to claim 13, Daniels in view Lee (321) teaches the method of claim 1, wherein exposing the adhesion promoter layer and the hard mask layer to a free radical-generating energy source includes heating the adhesion promoter layer and the hard mask layer.

19. Pertaining to claim 14, Daniels in view Lee (321) teaches the method of claim 13, wherein the composite polymer dielectric film and the hard mask layer are heated under a mixture of hydrogen and a noble gas (column 13, lines 38-40 of Daniels).

20. Pertaining to claim 15, Daniels in view of Lee (321) teaches the method of claim 1, wherein exposing the adhesion promoter layer and the hard mask layer to a free radical-generating energy source includes exposing the adhesion promoter layer and the hard mask layer to a UV light source (column 13, line 11).

21. Pertaining to claim 16, Daniels in view of Lee (321) teaches a method of forming an electrically conductive element in an integrated circuit, the method comprising:
depositing a polymer dielectric film onto a substrate;
depositing a hard mask layer over the polymer dielectric film;
forming a patterned film of a resist material on the hard mask layer;
etching an etched feature into the composite polymer dielectric layer;
annealing the etched feature in a reducing atmosphere including hydrogen; and
depositing an electrically conductive material in the etched feature (see embodiment 4 of Daniels).

22. Pertaining to claim 17, Daniels in view of Lee (321) teaches the method of claim 16, wherein the polymer dielectric layer is formed at least partially from a fluorine-containing polymer having a dielectric constant of less than 2.6 (column 8, line 5).

23. Pertaining to claim 18, Daniels in view of Lee (321) teaches the method of claim 16, wherein the polymer dielectric layer is a composite film including a low dielectric constant polymer layer disposed between and chemically bonded to a first organosilane-containing layer and a second organosilane containing layer.

24. Pertaining to claim 19, Daniels in view of Lee (321) teaches the method of claim 18, wherein the low dielectric constant polymer layer
is formed from a poly(paraxylylene)-based polymer.

25. Pertaining to claim 20, Daniels in view of Lee (321) teaches the method of claim 18, wherein the first organosilane-containing layer and the second organosilane-containing layer are formed from at least one material having a general structure of $(RZ)_x$-Si-$(W\text{-}T)_y$, wherein W is selected from the group consisting of =O-, $=CH_2=$, $-(CH_2)_aC=OO-$, and $-(CH_2)_a-OO=C-$;

wherein T is selected from the group consisting of -C'R=CR'R", an alkyl halide, and -RC=O;

wherein Z is selected from the group consisting of O and NR;

wherein R, R' and R" are an H, alkyl or aromatic group;

wherein a is 0 or an integer;

wherein x = 1, 2 or 3;

wherein y = 1, 2 or 3; and

wherein x + y = 4.

26. Pertaining to claim 21, Daniels in view of Lee (321) teaches the method of claim 16, wherein annealing the etched feature in the presence of a reducing atmosphere including hydrogen includes annealing the etched feature at a temperature of between approximately 300 and 400 degrees Celsius.

27. Pertaining to claim 22, Daniels in view of Lee (321) teaches the method of claim 21, wherein annealing the etched feature in the presence of a reducing atmosphere including hydrogen includes annealing the etched feature for a duration of between approximately 2 and 10 minutes.

28. Pertaining to claim 23, Daniels in view of Lee (321) teaches the method of claim 16, wherein annealing the etched feature in the presence of a reducing atmosphere including hydrogen includes annealing the etched feature in a mixture of hydrogen and argon.

29. Pertaining to claim 24, Daniels in view of Lee (321) teaches the method of claim 23, wherein the etched feature is annealed in a mixture, of 10% hydrogen and argon.

30. Given the teaching of the references, it would have been obvious to determine the optimum thickness, temperature as well as condition of delivery of the layers involved. See *In re Aller, Lacey and Hall* (10 USPQ 233-237) "It is not inventive to discover optimum or workable ranges by routine experimentation. Note that the specification contains no disclosure of either the critical nature of the claimed ranges or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen dimensions or upon another variable recited in a claim, the Applicant must show that the chosen dimensions are critical. *In re Woodruff*, 919 f.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990).

Any differences in the claimed invention and the prior art may be expected to result in some differences in properties. The issue is whether the properties differ to such an extent that the difference is really unexpected. *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986)

Appellants have the burden of explaining the data in any declaration they proffer as evidence of non-obviousness. *Ex parte Ishizaka*, 24 USPQ2d 1621, 1624 (Bd. Pat. App. & Inter. 1992).

An Affidavit or declaration under 37 CFR 1.132 must compare the claimed subject matter with the closest prior art to be effective to rebut a prima facie case of obviousness. *In re Burckel*, 592 F.2d 1175, 201 USPQ 67 (CCPA 1979).

31. Pertaining to claim 25, Daniels in view of Lee (321) teaches an integrated circuit, a method of forming an electrical connection to an underlying electrically conductive element, wherein the electrically conductive element is disposed within a first polymer dielectric film, the method comprising:

forming a second polymer dielectric film over the electrically conductive element and the first polymer dielectric film, wherein the second polymer dielectric film has a composite structure including a first silane-containing adhesion promoter layer chemically bonded to a first low dielectric constant polymer layer;

forming an etch stop layer over the second polymer dielectric film;

forming a third polymer dielectric film over the etch stop layer;

forming a hard mask layer over the third dielectric film, the etch stop layer, and the second polymer dielectric film to expose the electrically conductive element;

etching a trench through the third polymer dielectric film such that the trench at least partially overlaps the via; and

depositing an electrically conductive material in the via and the trench, wherein the electrically conductive material contacts the electrically conductive element in the first polymer dielectric layer.

32. Pertaining to claim 26, Daniels in view of Lee (321) teaches the method of claim 25, wherein the third polymer dielectric film includes a second silane-containing adhesion promoter layer and a second low dielectric constant polymer layer.

33. Pertaining to claim 27, Daniels in view of Lee (321) the method of claim 25, wherein the etch stop layer is formed from an organosilane material having a general structure of $(RZ)_x$-S-$(W\text{-}T)_y$, wherein W is selected from the group consisting of -O-, $-CH_2-$, $-(CH2)_aC{=}OO-$, and $-(CH_2)a\text{-}OO{=}C-$;

wherein T is selected from the group consisting of -CR=CR'R", an alkyl halide, and RC=O;

wherein Z is selected from the group consisting of O and NR;

wherein R, R' and R" are an H, alkyl or aromatic group;

wherein a is 0 or an integer; wherein x = 1, 2 or 3;

wherein y = 1, 2 or 3; and wherein x + y = 4.

34. Pertaining to claim 28, Daniels in view of Lee (321) teaches the method of claim 27, wherein the organosilane material has a general structure of $(RZ)_3$-Si-(W-T').

35. Pertaining to claim 29, Daniels in view of Lee (321) teaches the method of claim 25, wherein the adhesion promoter layer is formed from an organosilane material having a general structure of (RZ)x-Si-(W-T)Y, wherein W is selected from the group consisting of -O-, $-CH_2-$, $-(CH_2)_aC{=}00-$, and $-(CH_2)_a\text{-}00{=}C-$; wherein T is selected from the group consisting of -CR=CR'R", an alkyl halide, and. RC=O; wherein Z is selected from the group consisting of O and NR; Wherein R, R' and R" are an H; alkyl or aromatic group; wherein a is 0 or an integer; wherein x = 1, 2 or 3; wherein y = 1, 2 or 3; and wherein x + y = 4.

36. Pertaining to claim 30, Daniels in view of Lee (321) teaches the method of claim 25, wherein the hard mask layer is formed from an organosilane material having a general structure of (RZ,)x Si-(W-T)y, wherein W is selected from the group consisting of -0-, -CH_2-, -$(CH_2)_aC$=00-, and -$(CH_2)_a$-OO=C-; wherein T is selected from the group consisting of -CR=CR'R", an alkyl halide, and RC=0; wherein Z is select,,d from the group consisting of 0 and NR; wherein R, R' and R" are an H, alkyl or aromatic group; wherein a is 0 or an integer; wherein x = 1, 2 or 3; Wherein y = 1, 2 or 3; arid wherein x + y =- 4.

37. Pertaining to claim 31, Daniels in view of Lee (321) teaches the method of claim 30, Wherein the organosilane material has a general structure of (RZ)-Si-$(W-T)_3$.

38. Pertaining to claim 32, Daniels in view of Lee (321) teaches the method of claim 25, further comprising exposing the second polymer dielectric film to a free radical-generating energy source to chemically bond the first adhesion promoter layer to the first low dielectric constant polymer layer before depositing the third polymer dielectric layer.

39. Pertaining to claim 33, Daniels in view of Lee (321) teaches the method of claim 32, further comprising exposing the etch stop layer to a free radical=generating energy source to, chemically bond the etch stop layer to the first low dielectric constant polymer layer.

40. Pertaining to claim 34, Daniels in view of Lee (321) teaches the method of claim 33, further comprising exposing the third polymer dielectric film to the free radical-generating energy source to chemically bond the third polymer dielectric film to the etch stop layer.

41. Pertaining to claim 35, Daniels in view of Lee (321) teaches the method of claim 34, further comprising exposing the hard mask layer to- the free radical-generating energy source to chemically bond the hard mask layer to the third polymer dielectric layer.

42. Pertaining to claim 36, Daniels in view of Lee (321) teaches the method of claim 25, wherein the third polymer dielectric layer includes a second adhesion promoter layer and a second low dielectric constant polymer layer, further comprising exposing the third polymer dielectric layer to a free radical-generating energy course to chemically bond the second adhesion promoter layer to the second low dielectric constant polymer layer.

43. Pertaining to claim 37, Daniels in view of Lee (321) teaches the method of claim 25, further comprising annealing the via and the trench in a reducing atmosphere before; depositing the electrically conductive material in the via and the trench.

44. Pertaining to claim 38, Daniels in view of Lee (321) teaches the method of claim 37, wherein the via and the trench are annealed in a mixture of hydrogen in a noble gas.

Conclusion

45. Any inquiry concerning this communication or earlier communications from the examiner should be directed to W. David Coleman whose telephone number is 571-272-1856. The examiner can normally be reached on Monday-Friday 9:00 AM - 5:30 PM.

46. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on 571-272-1855. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

47. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

W. David Coleman
Primary Examiner
Art Unit 2823

WDC